CSIR UGC – NET JRF: June 2013

Chemical Science

❖ Question Paper

Section-A

Q.1 During an evening party, when Ms. Black, Ms. Brown and Ms. White met, Ms. Brown remarked, "it is interesting that our dresses are white, black or brown, but for each of us the name does not match the colour of the dress!". Ms. White replied, "But your white dress does not suit you!". Pick the correct answer

(a) Ms. White's dress was brown.

(b) Ms. black's dress was white.

(c) Ms. White's dress was black.

(d) Ms. Black's dress was black.

Q.2 Of all the triangles that can be inscribed in a semicircle of radius R with the diameter as one side, the biggest one has the area

(a) R^2 (b) $R^2\sqrt{2}$ (c) $R^2\sqrt{3}$ (d) $2R^2$

Q.3 A square pyramid is to be made using a wire such that only one strand of wire is used for each edge. What is the minimum number of times that the wire has to be cut in order to make the pyramid?

(a) 3 (b) 7 (c) 2 (d) 1

Q.4

(a) 

(b) 

(c) 

(d) 

Q.5 In a customer survey conducted during Monday to Friday, of the customers who asked for child care facilities in super markets, 23% were men and the rest, women. Among them, 19.9% of the women and 8.8% of the men were willing to pay for the facilities.

(A) What is the ratio of the men to women customers who wanted child care facilities?

(B) If the survey had been conducted during the weekend instead, how will the result change?

With the above data,

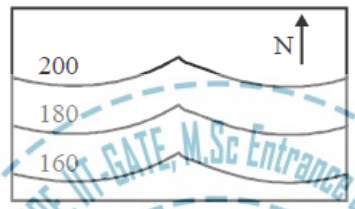
(a) Only A can be answered.

(b) Only B can be answered.

(c) Both A and B can be answered.

(d) Neither A Nor B can be answered.

Q.6 The map given below shows contour lines which connect points of equal ground surface elevation in a region. Inverted 'V' shaped portions of contour lines represent a valley along which a river flows. What is the downstream direction of the river?

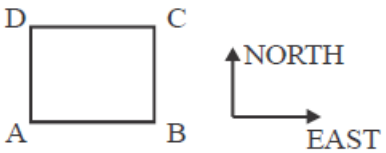


(a) North (b) South (c) East (d) West

Q.7 During a summer vacation, of 20 friends from a hostel, each wrote a letter to each of all others. The total number of letters written was

(a) 20 (b) 400 (c) 200 (d) 380

Q.8 A person has to cross a square field by going from A to C. The person is only allowed to move towards the east or towards the north or use a combination of these movements. The total distance travelled by the person



(a) Depends on the length of each step.

(b) Depends on the total number of steps.

(c) Is different for different paths

(d) Is the same for all paths.

Q.9 A crow is flying along a horizontal circle of radius R at a height R above the horizontal ground. Each of a number of men on the ground found that the angular height of the crow was a fixed angle $\theta(< 45^{o})$ when it was closest to him. Then all these men must be on a circle on the ground with a radius

(a) $R + R \sin\theta$ (b) $R + R \cos\theta$ (c) $R + R \tan\theta$ (d) $R + R \cot\theta$

Q.10 How many pairs of positive integers have gcd 20 and lcm 600?

(gcd = greatest common divisor, lcm = least common multiple)

(a) 4 (b) 0 (c) 1 (d) 7

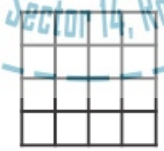
Q.11 Two integers are picked at random from the first 15 positive integers without replacement. What is the probability that the sum of the two numbers is 20?

(a) 3/4 (b) 1/21 (c) 1/105 (d) 1/20

Q.12 A daily sheet calendar of the year 2013 contains sheets of 10×10 cm size. All the sheets of the calendar are spread over the floor of a room of 5m×7.3m size. What percentage of the floor will be covered by these sheets?

(a) 0.1 (b) 1 (c) 10 (d) 100

Q.13 How many rectangles (which are not squares) are there in the following figure?



(a) 56 (b) 70 (c) 86 (d) 100

Q.14 Define $a \otimes b = l\,cm(a, b) + gcd(a, b)$ and $a \otimes b = a^b + b^a$. What is the value of $(1 \otimes 2) \otimes (3 \otimes 4)$? Her lcm = least common multiple and gcd = greatest common divisor.

(a) 145 (b) 286 (c) 436 (d) 572

Q.15 There is an equilateral triangle in the XY plane with its centre at the origin. The distance of its sides from the origin is 3.5 cm. The area of its circumcircle in cm^2 is:

(a) 38.5 (b) 49 (c) 63.65 (d) 154

Q.16 What is the value of $\frac{1}{1\times2}+\frac{1}{2\times3}+\frac{1}{3\times4}+\cdots\ldots to\ \infty$

(a) 2/3 (b) 1 (c) 2 (d) ∞

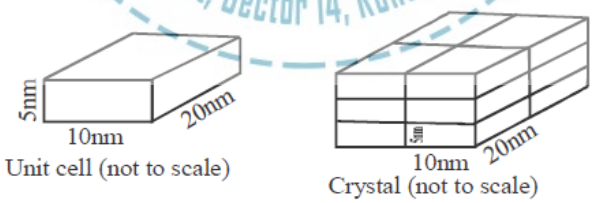
Q.17 A sphere of iron of radius R/2 fixed to one end of a string was lowered into water in a cylindrical container of base radius R to keep exactly half the sphere dipped. The rise in the level of water in the container will be

(a) R/3 (b) R/4 (c) R/8 (d) R/12

Q.18 Choose the largest number

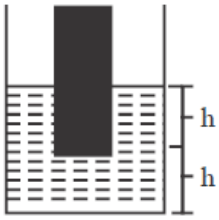
(a) 2^{500} (b) 3^{400} (c) 4^{300} (d) 5^{200}

Q.19 A crystal grows by stacking of unit cells of 10×20×5 nm size as shown in the diagram given below. How many unit cells will make a crystal of 1 cm3 volume?



(a) 10^6 (b) 10^9 (c) 10^{12} (d) 10^{18}

Q.20 A solid cylinder of basal area A was held dipped in water in a cylindrical vessel of basal area 2A vertically such that a length 'h' of the cylinder is immersed. The lower tip of the cylinder is at a height 'h' from the base of the vessel. What will be the height of water in the vessel when the cylinder is taken out?



(a) 2h (b) 3/2 h (c) 4/3 h (d) 5/4 h

Section-B

Q.21 Which of the following pairs has the highest difference in their first ionization energy?

(a) Xe, Cs (b) Kr, Rb (c) Ar, K (d) Ne, Na

Q.22 The ligand in uranocene is:

(a) $C_8H_8^{2-}$ (b) $C_5H_5^{2-}$ (c) C_6H_6 (d) $C_4H_4^{2-}$

Q.23 In metal-olefin interaction, the extent of increase in metal → olefin π – back – donation would

(a) Lead to a decrease in C = C bond length.

(b) Change the formal oxidation state of the metal.

(c) Change the hybridization of the olefin carbon from sp^2 to sp^3.

(d) Increase with the presence of electron donating substituent on the olefin.

Q.24 The oxidation state of molybdenum in $[(\eta^7 - \text{tropylium})Mo(CO)_3]^+$ is

(a) +2 (b) +1 (c) 0 (d) -1

Q.25 The reaction of $[PtCl_4]^{2-}$ with two equivalent of NH_3 produces

(a) cis -[$Pt(NH_3)_2Cl_2$] (b) trans -[$Pt(NH_3)_2Cl_2$]

(c) Both cis, trans -[$Pt(NH_3)_2Cl_2$] (d) cis -[$Pt(NH_3)_2Cl_4]^{2-}$

Q.26 The electronic transition responsible for the color of the transition metal ions is

(a) $d_\pi \rightarrow d_\sigma$ (b) $d_\pi \rightarrow d_{\sigma^*}$ (c) $d_\pi \rightarrow d_{\pi^*}$ (d) $d_\sigma \rightarrow d_{\pi^*}$

Q.27 The number of metal-metal bonds in $[W_2(OPh)_6]$ is:

(a) 1 (b) 2 (c) 3 (d) 4

Q.28 The Mullikan symbols for the spectroscopic states arising from the free-ion term F are

(a) $T_{2g} + E_g$ (b) $T_{1g} + T_{2g} + T_{1u}$ (c) $T_{1g} + T_{2g} + A_{2g}$ (d) $A_{1g} + T_{2g} + T_{1g}$

Q.29 Which of the following is used as propellant for whipping creams?

(a) N_2O (b) NO (c) N_2O_3 (d) N_2O_5

Q.30 Flame proof fabrics contain

(a) $H_2NC(O)NH_2.Na_2SO_4$ (b) $H_2NC(S)NH_2.Na_2SO_4$

(c) $H_2NC(O)NH_2.H_3PO_4$ (d) $H_2NC(S)NH_2.H_3PO_4$

Q.31 Among the compounds A-D, those which hydrolyse easily are

A. NCl_3; B. NF_3; C. $BiCl_3$; D. PCl_3

(a) A and B only (b) A, C and D only (c) B,C and D only (d) A, B and C only

Q.32 The coordination geometry of copper (II) in the type I copper protein plastocyanin is:

(a) Square planar (b) Tetrahedral (c) Octahedral (d) Distorted tetrahedral

Q.33 The metal ions present in the active site of nitrogenase enzyme co-factor are

(a) Fe, Mo (b) Fe, W (c) Fe, Cu (d) Fe, Ni

Q.34 The reaction,

$$[(CO)_5Mn(Me)] + CO \rightarrow [(CO)_5Mn\{C(O)Me\}]$$

Is an example of

(a) Oxidative addition (b) Electrophilic substitution

(c) Nucleophilic substitution (d) Migratory insertion

Q.35 The number of EPR signals observed for octahedral Ni(II) complexes is

(a) One (b) Two (c) Three (d) Zero

Q.36 For neutron activation analysis of an element, the favorable characteristics of both the target and the product are from the following

(A) high neutron cross-section area of target

(B) long half-life of the product

(C) low neutron cross-section area of target

(D) low half-life time of the product.

The correct characteristics from the above are

(a) A and B (b) C and D (c) B and C (d) A and D

Q.37 The concentrations of a species A undergoing the reaction A → P is 1.0, 0.5, 0.33, 0.25 mol dm^{-3} at t = 0, 1, 2 and 3 seconds, respectively. The order of the reaction is:

(a) Two (b) One (c) Zero (d) Three

Q.38 The difference in energy levels of n = 2 and n = 1 of a particle in a one dimensional box is 6 units of energy. In the same units, what is the difference in energy levels of n = 3 and n = 2 for the above system?

(a) 4 (b) 5 (c) 9 (d) 10

Q.39 The wave function Ψ of a certain system is the linear combination

$$\Psi = \sqrt{\frac{1}{4}}\,\Psi_1 + \sqrt{\frac{3}{4}}\,\Psi_2$$

where Ψ_1 and Ψ_2 are energy eigen functions with eigen values (non-degenerate) E_1 and E_2, respectively. What is the probability that the system energy will be observed to be E1?

(a) $\sqrt{\frac{3}{16}}$ (b) $\frac{3}{4}$ (c) $\frac{1}{4}$ (d) $\sqrt{\frac{1}{4}}$

Q.40 What is the atomic term symbol for helium atom with electronic configuration $1s^2$?

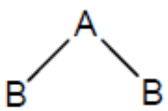
(a) $^2S_{1/2}$ (b) $^1P_0$ (c) $^1S_0$ (d) $^1S_1$

Q.41 A molecules contains the following symmetry operations: E, $2C_6$, $2C_3$, C_2, $3\sigma_d$, $3\sigma_v$. The number of classes and order of the symmetry point group is:

(a) 3, 12 (b) 5,12 (c) 6, 12 (d) 6, 6

Q.42 A triatomic molecule of the type AB_2 shows two IR absorption lines and one IR-Raman line. The structure of the molecule is:

(a) B – B – A (b) B – A – B (c) 

(d) 

Q.43 In NMR spectroscopy, the product of the nuclear 'g' factor (g_N), the nuclear magneton (β_N) and the magnetic field strength (B_0) gives the

(a) Energy of transition from α to β state (b) Chemical shift

(c) Spin-spin coupling constant (d) Magnetogyric ratio

Q.44 An aqueous mixed solution of NaCl and HCl is exactly neutralized by an aqueous NaOH solution. The number of components in the final mixture is

(a) 1 (b) 2 (c) 3 (d) 4

Q.45 The lowest pressure at which the liquid phase of a pure substance can exist is known as

(a) Critical point pressure. (b) Super-incumbent pressure.

(c) Triple-point pressure. (d) Saturation vapour pressure.

Q.46 A chemical reaction involving

nonlinear molecule + nonlinear molecule ⇄ nonlinear activated complex

The number of vibrational degrees of freedom in the activated complex, containing N atoms, is

(a) 3N – 5 (b) 3N – 6 (c) 3N – 7 (d) 3N – 8

Q.47 Calculate the total number of microstates for 6 identical particles with their occupation numbers {1, 2, 3} in three states is:

(a) 6 (b) 12 (c) 60 (d) 720

Q.48 If the concentration (c) is increased to 4 times its original value (c), the change in molar conductivity for strong electrolytes is (where b is Kohlrausch constant)

(a) 0 (b) $b\sqrt{c}$ (c) $2b\sqrt{c}$ (d) $4b\sqrt{c}$

Q.49 In atom recombination reactions

(a) $E_a = 0$, $\Delta S^{\#} = +ve$, $\Delta H^{\#} = +ve$ (b) $E_a = 0$, $\Delta S^{\#} = -ve$, $\Delta H^{\#} = -ve$

(c) $E_a = +ve$, $\Delta S^{\#} = -ve$, $\Delta H^{\#} = -ve$ (d) $E_a = +ve$, $\Delta S^{\#} = +ve$, $\Delta H^{\#} = +ve$

Q.50 In the Lindemann mechanism of unimolecular reactions, the observed order at low concentration is

(a) 0.1 (b) 1 (c) 1.5 (d) 2

Q.51 The aggregation of surfactant molecules is known as

(a) Micelles (b) Clusters (c) Gel (d) Colloid

Q.52 The coordinates for the atoms in a body centred cubic unit cell are

(a) (0, 0, 0) and (1/2, 0, 0) (b) (0, 0, 0) and (1/2, 1/2, 1/2)

(c) (0, 0, 0) and (0, 1/2, 0) (d) (0, 0, 0) and (0, 0, 1/2)

Q.53 The inter planar distance (Å) for a (100) plane in a cubic structure with the lattice parameter of 4Å is:

(a) 1 (b) 2 (c) 4 (d) 8

Q.54 The correlation coefficient of two parameters is found to be –0.99. It may be concluded that the two parameters are

(a) Strongly correlated (b) Almost uncorrelated

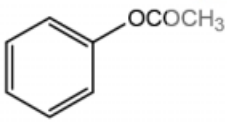
(c) Connected by a cause-effect relationship (d) Not connected by a cause-effect relationship

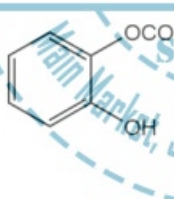
Q.55 The IUPAC name for the compound given below is

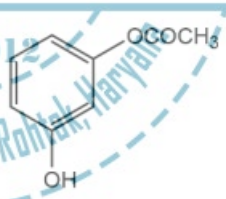
(a) (2R, 3Z)-7-phenylhept-3-en-2-ol (b) (2S, 3Z)-7-phenylhept-3-en-2-ol

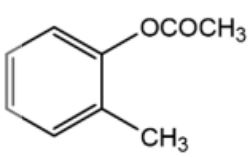
(c) (2R, 3E)-7-phenylhept-3-en-2-ol (d) (2S, 3E)-7-phenylhept-3-en-2-ol

Q.56 Among the following esters, the one that undergoes acid hydrolysis fastest is

(a) 

(b) 

(c) 

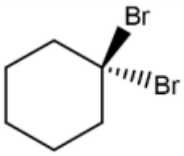
(d) 

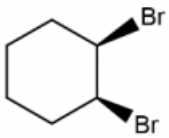
Q.57 Reaction of cyclohexyl benzyl ether in the presence of 10% Pd/C yields

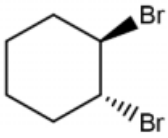
(a) Cyclohexanol and toluene (b) Cyclohexanol and benzyl alcohol

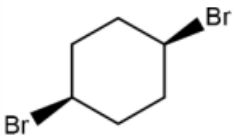
(c) Cyclohexane and benzyl alcohol (d) Cyclohexane and toluene

Q.58 Among the following dibromocyclohexanes, the one that reacts fastest with sodium iodide to give cyclohexene is

(a) 

(b) 

(c) 

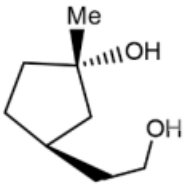
(d) 

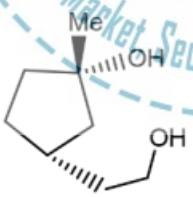
Q.59 Match the following drugs with their medicinal activity

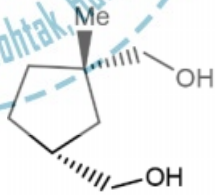
A. 5-fluorouracil	i. Anti-bacterial
B. Amoxicillin lowering	ii. Cholesterol
	iii. Anticancer
	iv. Anti-inflammatory

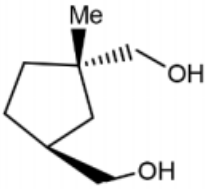
(a) A-i, B-ii (b) A-iv, B-iii (c) A-iii, B-iv (d) A-iii, B-i

Q.60 The major product formed in the following reaction sequence is

(a) 

(b) 

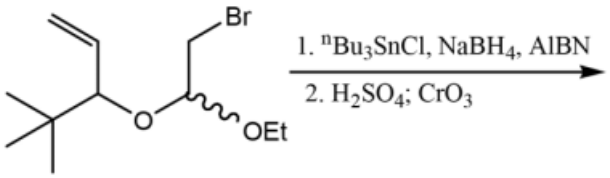
(c) 

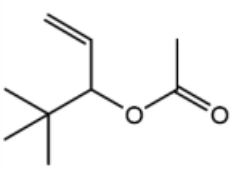
(d) 

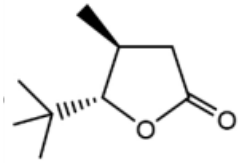
Q.61 The biosynthetic precursor for the steroids is

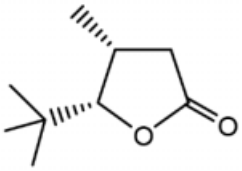
(a) Secologanin (b) Shikimic acid (c) Mevalonic acid (d) α - Ketoglutaric acid

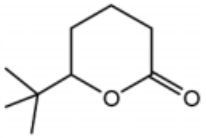
Q.62 The major product formed in the following reaction sequence is



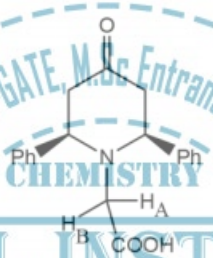
(a) 

(b) 

(c) 

(d) 

Q.63 In the compound given below, the hydrogenes marked A and B are

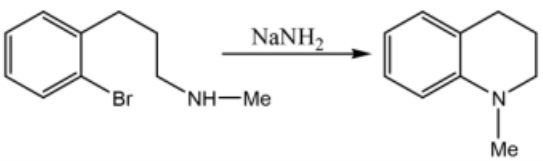


(a) Homotopic (b) Isotopic (c) Enantiotopic (d) Diastereotopic

Q.64 In the IR spectrum, the absorption band due to carbonyl group in phenyl acetate appears at

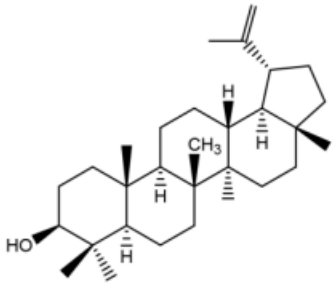
(a) 1800 cm^{-1} (b) 1760 cm^{-1} (c) 1710 cm^{-1} (d) 1660 cm^{-1}

Q.65 The reactive intermediate involved in the following reaction is:



(a) A carbocation (b) A carbanion (c) A free radical (d) An aryne

Q.66 Number of isoprene units present in lupeol is



(a) Two (b) Four (c) Six (d) Eight

Q. 67 The heterocyclic ring present in the amino acid histidine is

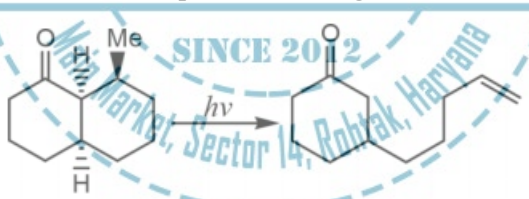
(a) Pyridine (b) Tetrahydropyrrole (c) Indole (d) Imidazole

Q.68 The gauche conformation ($\varphi = 60^{o}$) of n-butane possesses

(a) Plane of symmetry; and is achiral (b) C_2-axis of symmetry; and is chiral

(c) Centre of symmetry; and is achiral (d) Plane of symmetry; and is chiral

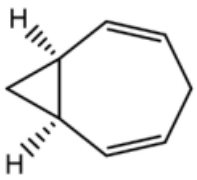
Q.69 The following photochemical conversion proceeds through

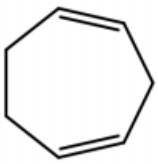


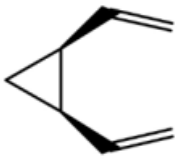
(a) Barton reaction. (b) Paterno-Buchi reaction.

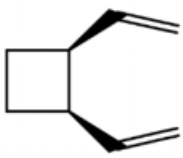
(c) Norrish type I reaction. (d) Norrish type II reaction.

Q.70 Among the following dienes, the one that undergoes a degenerate Cope rearrangement is

(a) 

(b) 

(c) 

(d) 

Section-C

Q.71 A radioisotope ^{41}Ar initially decays at the rate of 34, 500 disintegrations/minute, but decay rate falls to 21, 500 disintegrations/minute after 75 minutes. The $t_{1/2}$ for ^{41}Ar is:

(a) 90 minutes (b) 110 minutes (c) 180 minutes (d) 220 minuts

Q.72 The orders of reactivity of ligands, NMe_3, PMe_3 and CO with complexes $MeTiCl_3$ and $(CO)_5Mo(thf)$ are

(a) $CO > PMe_3 > NMe_3$ and $CO > NMe_3 > PMe_3$ (b) $PMe_3 > CO > NMe_3$ and $NMe_3 > CO > PMe_3$

(c) $NMe_3 > PMe_3 > CO$ and $CO > PMe_3 > NMe_3$ (d) $NMe_3 > CO > PMe_3$ and $PMe_3 > NMe_3 > CO$

Q.73 The number of lone-pairs are identical in the pairs

(a) XeF_4, ClF_3 (b) XeO_4, ICl_4^- (c) XeO_2F_2, ICl_4^- (d) XeO_4, ClF_3

Q74 Among the following, those can act as Mossbauer nuclei are

(A) ^{129}I; (B) ^{57}CO; (C) ^{57}Fe; (D) ^{121}Sb

(a) A, B, C and D (b) B, C and D only (c) A, B, and D only (d) A, C and D only

Q.75 Which of the pairs will generally result in tetrahedral coordination complexes, when ligands are Cl^- or OH^-

(A) Be(II), Ba(II); (B) Ba(II), Co(II); (C) Co(II), Zn(II); (D) Be(II), Zn(II)

(a) A and B (b) B and C (c) C and D (d) A and D

Q.76 Silica gel contains $[CoCl_4]^{2-}$ as an indicator. When activated, silica gel becomes dark blue while upon absorption of moisture, its colour changes to pale pink. This is because,

(a) Co(II) changes its coordination from tetrahedral to octahedral.

(b) Co(II) changes its oxidation state to Co(III).

(c) Tetrahedral crystal field splitting is NOT equal to octahedral crystal field splitting

(d) Co(II) forms kinetically labile while Co(III) forms kinetically inert complexes

Q.77 For the metalloprotein hemerythrin, the statement that is NOT TRUE is

(a) There are two ion centres per active site.

(b) Both iron centres are hexacoordinated in the active state

(c) One iron is hexacoordinated while the other is pentacoordinated in the active state.

(d) It is found in marine invertebrates.

Q.78 For a tetragonally distorted Cr(III) complex, zero-field splitting results in the following number of Kramers doublets:

(a) 1 (b) 2 (c) 3 (d) 4

Q.79 Intense band at 15000 cm^{-1} in the UV-visible spectrum of $[Bu_4N]_2Re_2Cl_8$ is due to the transition

(a) $\pi - \pi^*$ (b) $\delta - \delta^*$ (c) $\delta - \pi^*$ (d) $\pi - \delta^*$

Q.80 Electron change in reduction of $Ce(SO_4)_2$, $KMnO_4$, HNO_2 and I_2 with hydrazine in acidic medium, respectively is

(a) 1e, 1e, 2e and 4e (b) 1e, 3e, 2e and 4e (c) 2e, 3e, 1e and 4e (d) 2e, 4e, 1e and 3e

Q.81 The compound that will behave as an acid in H_2SO_4 is

(a) CH_3COOH (b) HNO_3 (c) $HClO_4$ (d) H_2O

Q.82 Among the oxides of nitrogen, N_2O_3, N_2O_4 and N_2O_5, the compound(s) having N–N bond is/are

(a) N_2O_4 and N_2O_5 (b) N_2O_3 and N_2O_5 (c) N_2O_3 and N_2O_4 (d) N_2O_5 only

Q.83 The treatment of PhBr with n-BuLi yields:

(a) 2 n-BuPh + Br_2 + Li_2 (b) PhPh + octane + 2LiBr

(c) n-BuPh + LiBr (d) PhLi + n-BuBr

Q.84 Though cyclobutadiene (C_4H_4) is highly unstable and readily polymerizes in its free stae, its transition metal complexes could be isolated because

(a) It engages in long-range interaction with transition metals.

(b) It gains stability due to formation of $C_4H_4^{2-}$ on binding to transition metals.

(c) Its polymerization ability reduces in presence of transition metal.

(d) It becomes stable in presence of transition metals due to formation of $C_4H_4^{2+}$.

Q.85 Identify the order representing increasing π – acidity of the following ligands

C_2F_4, NEt_3, CO and C_2H_4

(a) $CO < C_2F_4 < C_2H_4 < NEt_3$ (b) $C_2F_4 < C_2H_4 < NEt_3 < CO$

(c) $C_2H_4 < NEt_3 < CO < C_2F_4$ (d) $NEt_3 < C_2H_4 < C_2F_4 < CO$

Q.86 The species with highest magnetic moment (spin only value) is

(a) VCl_6^{4-} (b) $(\eta^5\text{-}C_5H_5)_2Cr$ (c) $[Co(NO_2)_6]^{3-}$ (d) $[Ni(EDTA)]^{2-}$

Q.87 The number of metal-metal bonds in $Ir_4(CO)_{12}$

(a) 4 (b) 6 (c) 10 (d) 12

Q.88 Three bands in the electronic spectrum of $[Cr(NH_3)_6]^{3+}$ are due to the following transitions

A. $^4A_{2g} \rightarrow {}^4T_{1g}$

B. $^4A_{2g} \rightarrow {}^4T_{2g}$

C. $^4A_{2g} \rightarrow {}^2A_g$; Identify the correct statement about them

(a) Intensity of (A) is lowest. (b) Intensity of (C) is lowest.

(c) Intensities of (A), (B) and (C) are similar. (d) Intensities of (B) and (C) are similar.

Q.89 Identify the pairs in which the covalent radii of elements are almost similar

(A) Nb , Ta; (B) Mo, W; (C) La, Lu; (D) Sc, Y

(a) A and B only (b) A and C only (c) B and C only (d) A, B and C only

Q.90 Consider following lanthanide (III) ions: (A) Nd(III); (B) Gd(III); (C) Dy(III);

The magnetic moment closest to the spin only value is(are) for

(a) B only (b) A and B only (c) A and C only (d) B and C only

Q.91 The Δ_t of the following complexes

A. $[CoCl_4]^{2-}$; B. $[CoBr_4]^{2-}$; C. $[Co(NCS)_4]^{2-}$

Follows the order:

(a) C > A > B (b) A > B > C (c) B > A > C (d) C > B > A

Q.92 In complexometric titration

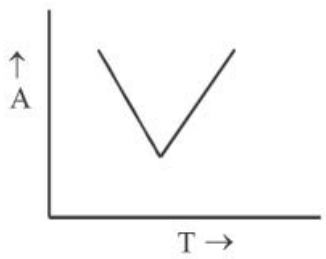
S(substrate) + T(titrant) → P(product)

The end point is estimated spectrophotometrically. If S and P have $\epsilon = 0$, the shape of the titration curve would look like

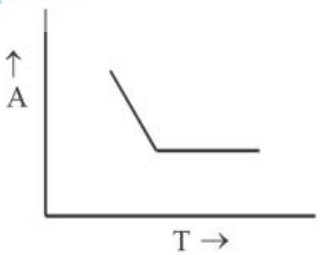
(a)

(b)

(c)



(d)



Q.93 Identify the chiral complexes from the following

A. $[Cr(EDTA)]^-$; B. $[Ru(bipy)_3]^{3+}$; C. $[PtCl(diene)]^+$.

(a) A only (b) A and B only (c) A and C only (d) B and C only

Q.94 Distribution ratio of 'A' between $CHCl_3$ and water is 9.0. It is extracted with several, 5 mL aliquots of $CHCl_3$. The number of aliquots needed to extract 99.9% of 'A' from its 5mL aqueous solution are

(a) 2 (b) 3 (c) 4 (d) 5

Q.95 The correct equilibrium order for the interconversion of different forms of SiO_2 is

(a) Tridymite ⇌ quartz ⇌ cristobalite ⇌ liquid SiO_2.

(b) Quartz ⇌ Tridymite ⇌ Cristobalite ⇌ liquid SiO2.

(c) Quartz ⇌ Cristobalite ⇌ tridymite ⇌ liquid SiO_2

(d) Cristobalite ⇌ tridymite ⇌ quartz ⇌ liquid SiO_2

Q.96 The rate equation for the reaction $2AB + B_2 \rightarrow 2AB_2$ is given by

rate = $k[AB]\,[B_2]$

A possible mechanism consistent with this rate law is

(a) $2AB + B_2 \xrightarrow{slow} 2AB_2$

(b) $AB + AB \rightleftharpoons A_2B_2$ (Fast)

$A_2B_2 + B_2 \xrightarrow{slow} 2AB_2$

(c) $AB + B_2 \xrightarrow{slow} AB_3$

$AB_3 + AB \xrightarrow{fast} 2AB_2$

(d) $AB + B_2 \rightleftharpoons AB_3$ (Fast)

$AB_3 + AB \xrightarrow{slow} 2AB_2$

Q.97 Observe the following statements

(I) In the H_2–O_2 reaction, explosion occurs when the rate of chain branching exceeds that of chain termination.

(II) The order of the reaction, nA → products, is 2.5. For this reaction,

$t_{/2} \propto [A]_0^{-3/2}$

(III) Unimolecular gas phase reactions are second order at low pressure but becomes first order at high pressure. Which of the following is correct?

(a) I, II and III are correct (b) Only II is correct

(c) Only III is correct (d) I and II are correct

Q.98 For the particle-in-a-box problem in (0, L) an approximate wave function is given as x (L/2 – x) (L – x). The average energy E for such a state will obey

(a) $\frac{h^2}{8mL^2} < \bar{E} < \frac{h^2}{2mL^2}$ (b) $\bar{E} > \frac{h^2}{2mL^2}$

(c) $\frac{h^2}{4mL^2} < \bar{E} < \frac{h^2}{2mL^2}$ (d) $0 < \bar{E} < \frac{h^2}{8mL^2}$

Q.99 For two variables x and y, the following data set is given:

x	y
–1	1
0	2
1	3

The correct statement for the covariance A and correlation coefficient B of x and y is

(a) A = 2/3, B = 1 (b) A = –2/3, B = 1 (c) A = –2/3, B = –1 (d) A = 0, B =0

Q.100 The hydrogenic orbital with the form of the radial function $r^2(\alpha_1 - r)(\alpha_2 - r)\exp[-\beta r]$, Where α_1, α_2 *and* β are constants, may be defined as a

(a) 3d orbital (b) 4f orbital (c) 5d orbital (d) 5f orbital

Q.101 The operator [x, [x, p^2]] is identical with

(a) [px, [x, p]] (b) [xp, [x, p]] (c) – [p, [x^2, p]] (d) [x, [x^2, p]]

Q.102 For the particle -in-a-box problem in (0, L), the value of $\langle x^3 \rangle$ in the n → ∞ limit would be

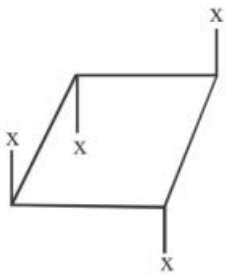
(a) $\frac{L^3}{6}$ (b) $\frac{L^3}{3}$ (c) $\frac{L^3}{4}$ (d) $\frac{L^4}{4}$

Q.103 Identify the Mullikan notation for the following irreducible representation

E	C_n	nC_2	i	σ_h
1	1	–1	–1	–1

(a) A_{1u} (b) A''_{2u} (c) B'_{2u} (d) A'_{2u}

Q.104 Identify the point group symmetry of the following molecule (all C–C bond lengths are equal)



(a) C_{2v} (b) S_4 (c) D_{2d} (d) D_{4d}

Q.105 The ground state term symbol for Nb(atomic number 41) is ^6D. The electronic configuration corresponding to this term symbol is

(a) $[Kr]4d^35s^2$ (b) $[Kr]4d^45s^1$ (c) $[Kr]4d^55s^0$ (d) $[Kr]4d^35s^15p^1$

Q.106 In the presence of an external magnetic field (normal Zeeman effect), the transition $^1D_2 \rightarrow {}^1P_1$ splits into

(a) 9 lines (b) 8 lines (c) 7 lines (d) 6 lines

Q.107 Identify the Huckel determinant for cyclobutadiene

(a) $\begin{vmatrix} \alpha-E & \beta & 0 & 0 \\ \beta & \alpha-E & \beta & 0 \\ 0 & \beta & \alpha-E & \beta \\ 0 & 0 & \beta & \alpha-E \end{vmatrix}$ (b) $\begin{vmatrix} \alpha-E & \beta & 0 & \beta \\ \beta & \alpha-E & \beta & 0 \\ 0 & \beta & \alpha-E & \beta \\ \beta & \beta & 0 & \alpha-E \end{vmatrix}$

(c) $\begin{vmatrix} \alpha-E & \beta & 0 & \beta \\ \beta & \alpha-E & \beta & 0 \\ 0 & \beta & \alpha-E & \beta \\ \beta & 0 & \beta & \alpha-E \end{vmatrix}$ (d) $\begin{vmatrix} \alpha-E & \beta & 0 & \beta \\ \beta & \alpha-E & \beta & 0 \\ 0 & \beta & \alpha-E & \beta \\ 0 & 0 & \beta & \alpha-E \end{vmatrix}$

Q.108 On mixing 120 ml of 0.05 M CH_3COOH and 40 ml of 0.05 M of NaOH, the pH of the solution is ($pK_a = -\log K_a$)

(a) pKa + 0.69 (b) pKa + 0.301 (c) pKa (d) pKa – 0.69

Q.109 A system consists of gaseous H_2, O_2, H_2O and CO_2 where the amount of CO_2 is specified and the equilibrium constant for the reaction $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g)$ is known. The number of degrees of freedom of the system is

(a) 2 (b) 3 (c) 4 (d) 5

Q.110 "Colloids are thermodynamically unstable with reference to bulk but kinetically stable". Identify the correct pair

Statements	Reasons
A. Thermodynamically unstable	C. Interfacial surface tension
B. Kinetically stable	D. Electrical double layer

(a) A ↔ D and B ↔ C (b) A ↔ C and B ↔ D

(c) A ↔ C and B ↔ C (d) A ↔ D and B ↔ D

Q.111 An AX system gave 4 lines at 4.72, 4.6, 1.12 and 1.0 ppm away from the TMS using an NMR spectrometer operating at 100 MHz. What are the values of J_{AX} (in Hz) and δ_{AX} (in ppm), respectively

(a) 12 and 3.6 (b) 6 and 3.6 (c) 12 and 2.86 (d) 6 and 2.86

Q.112 The equilibrium population ratio (n_j / n_i) of a doubly-degenerate energy level (Ej) lying at energy 2 units higher than a lower non-degenerate energy level (Ej), assuming $k_BT = 1$ unit, will be

(a) $2e^{-2}$ (b) $2e^{2}$ (c) e^{2} (d) e^{-2}

Q.113 Which of the following statements is true for a cyclic process?

(a) $\oint dq = 0$ (b) $\oint dw = 0$

(c) Heat can be completely converted into work (d) Work can be completely converted into heat

Q.114 Identify, from the following, the correct ionic strengths for (A) 0.01 molal solution of NaCl and (B) a 0.01 molal solution of Na_2SO_4.

(a) (A) 0.010 mol kg^{-1} (B) 0.010 mol kg^{-1}

(b) (A) 0.010 mol kg^{-1} (B) 0.030 mol kg^{-1}

(c) (A) 0.010 mol kg^{-1} (B) 0.025 mol kg^{-1}

(d) (A) 0.010 mol kg^{-1} (B) 0.015 mol kg^{-1}

Q.115 A system has 100 degenerate energy levels and 100 bosons are kept in it. Find the entropy of the system at equilibrium.

(a) 10^{-2} k_B (b) 10^2 k_B (c) 460.6 k_B (d) 4.606 k_B

Q.116 Which is correct Nernst equation for redox reaction O + ne ⇌ R?

(a) $E = E^0 - \frac{RT}{nF} ln \frac{[O]}{[R]}$

(b) $\frac{[O]}{[R]} = e^{\frac{nF}{RT}(E-E^0)}$

(c) $\frac{[O]}{[R]} = e^{-\frac{nF}{RT}(E-E^0)}$

(d) $\frac{[O]}{[R]} = e^{\frac{RT}{nF}(E+E^0)}$

Q.117 A plane of spacing 'd' shows first order Bragg diffraction at angle θ . A plane of spacing 2d

(a) Shows Bragg diffraction at 2θ

(b) Shows Bragg diffraction at $\frac{\theta}{2}$

(c) Shows Bragg diffraction at $\sin^{-1}\left(\frac{sin\theta}{2}\right)$

(d) Shows Bragg diffraction at $\sin^{-1}\left(\frac{sin2\theta}{2}\right)$

Q.118 In the formation of H_2 molecules from 2H atoms placed at positions A and B, and separated by a distance r_{AB} , a part of the spatial wave function is

$$\Phi_A(1)\Phi_A(2) + \Phi_B(1) + \Phi_B(2)$$

(a) This is a covalent term and is important as $r_{AB} \rightarrow \infty$

(b) This is an ionic term and is important as $r_{AB} \rightarrow \infty$

(c) This is a covalent term and is important as $r_{AB} \rightarrow 0$

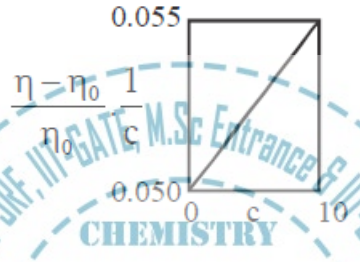
(d) This is an ionic term and is important as $r_{AB} \rightarrow 0$

Q.119 A 0.1 M solution of compound A shows 50% transmittance when a cell of 1 cm width is used at λ_1 nm. Another 0.1 M solution of compound B gives the optical density value of 0.1761 using 1cm cell at λ_1 nm. What will be the transmittance of a solution that is simultaneously 0.1 M in A and 0.1 M in B using the same cell and at the same wave length?

[log 20 = 1.301; log 30 = 1.4771; log 50 = 1.699]

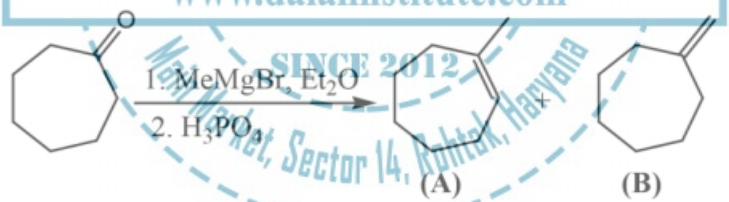
(a) 33.3% (b) 50% (c) 66.7% (d) 70%

Q.120 Using standard equation for intrinsic viscosity $[\eta] = K\bar{M}_V^a$, for a solution of polymer and any information from the graph identify viscosity average molar mass $(\bar{M})$ [given that a = 0.5, K = 5×10^{-5} L g^{-1}]



(a) 103 g/mol (b) 104 g/mol (c) 105 g/mol (d) 106 g/mol

Q.121 Among the following, the correct statement for the following reaction is



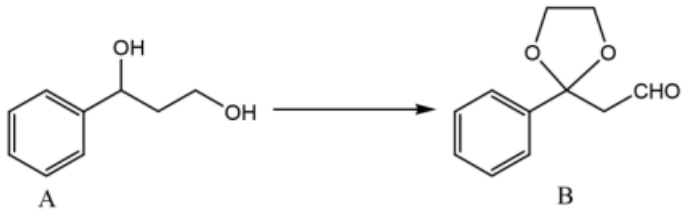
(a) A is the major product and it will have five signals in the proton decoupled ^{13}C NMR spectrum.

(b) A is the minor product and it will have eight signals in the proton decoupled ^{13}C NMR spectrum.

(c) B is the major product and it will have five signals in the proton decoupled ^{13}C NMR spectrum.

(d) B is the minor product and it will have five signals in the proton decoupled ^{13}C NMR spectrum.

Q.122 For the following three step conversion of A to B, the appropriate sequence of reactions is



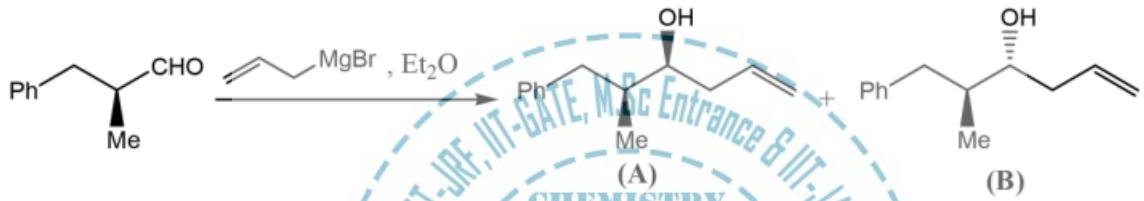
(a) MnO_2; $(CH_2OH)_2$/p-TSA; PCC

(b) PCC; MnO_2; $(CH_2OH)_2$/p-TSA

(c) PCC; $(CH_2OH)_2$/p-TSA; Jones' reagent

(d) Jones' reagent; $(CH_2OH)_2$/p-TSA; MnO_2

Q.123 Which one of the following statements is true for the following transformatio



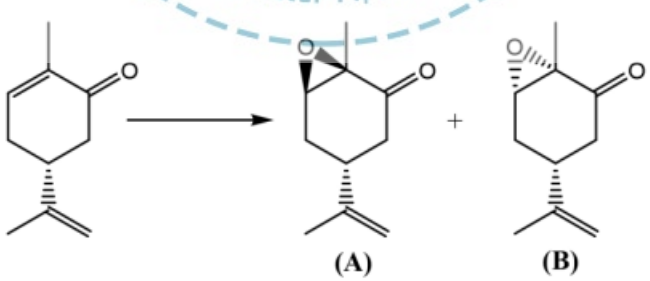
(a) A is the major product and it is a Cram product.

(b) A is the major product and it is anti-Cram product.

(c) B is the major product and it is a Cram product.

(d) B is the major product and it is anti-Cram product.

Q.124 Which one of the following statements is true for the following transformation?



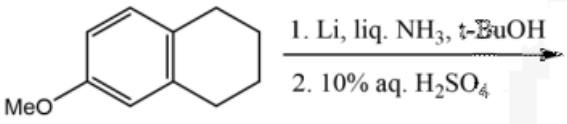
(a) Suitable reagent is m-CPBA and B is the major product.

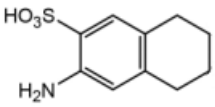
(b) Suitable reagent in m-CPBA and A is the major product.

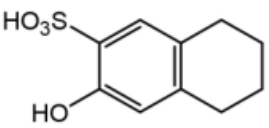
(c) Suitable reagent is aq. H_2O_2/NaOH and B is the major product

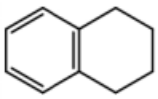
(d) Suitable reagent is aq. H_2O_2/NaOH and A is the major product.

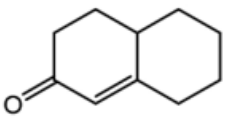
Q.125 The compound formed in the following reaction sequence is



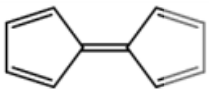
(a) 

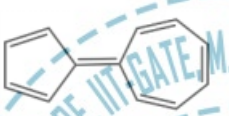
(b) 

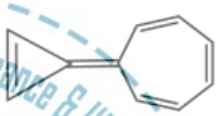
(c) 

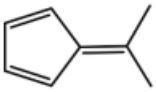
(d) 

Q.126 Among the following compounds, the one which has highest dipole moment is

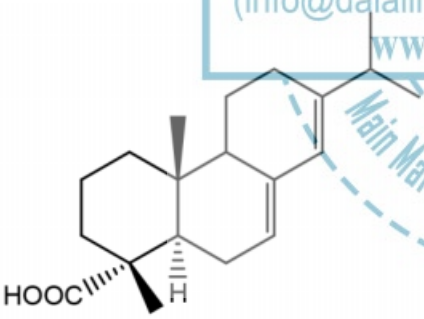
(a) 

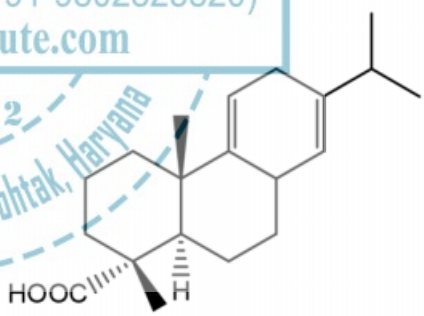
(b) 

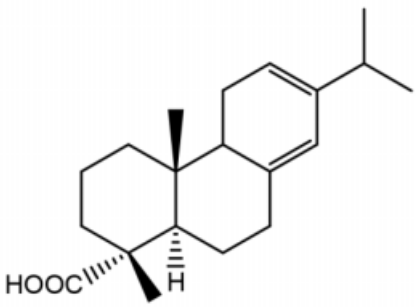
(c) 

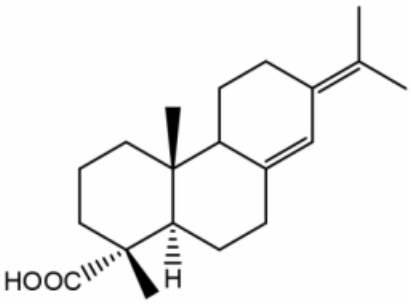
(d) 

Q.127 In the UV-V is spectrum, a diterpenoid exhibited a max λ_{max} at 275 nm. The compound, among the choices given below is

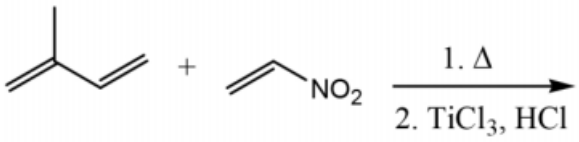
(a) 

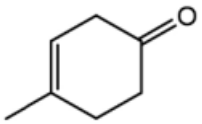
(b) 

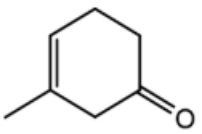
(c) 

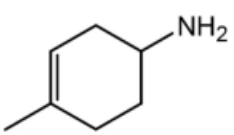
(d) 

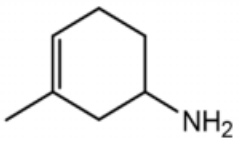
Q.128 The major product formed in the following reaction is



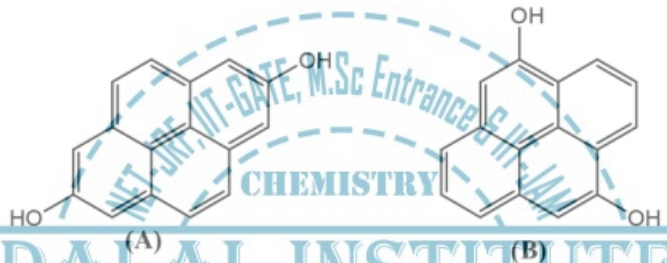
(a) 

(b) 

(c) 

(d) 

Q.129 In the broad band decoupled ^{13}C NMR spectrum, the number of signals appearing for the two pyrene-diols A and B

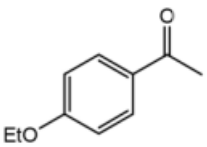


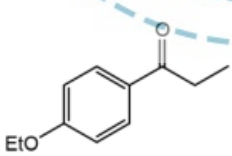
(a) Eight and eight (b) Eight and sixteen (c) Five and ten (d) Five and eight

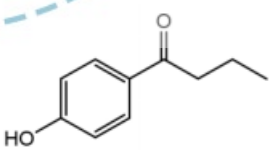
Q.130 An organic compound exhibited the following ^1H NMR spectra data:

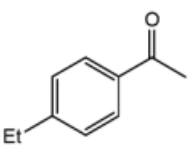
δ 7.80 (2H, d, J = 8Hz), 6.80 (2H, d, J = 8Hz), 4.10 (2H, q, J = 7.2Hz),

2.4 (3H, s), 1.25 (3H, t, J = 7.2Hz) The compound, among the choices given below is,

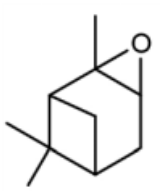
(a) 

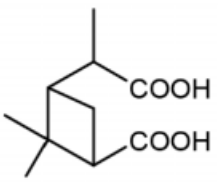
(b) 

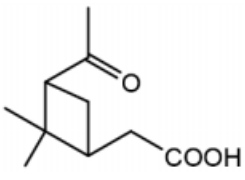
(c) 

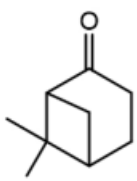
(d) 

Q.131 α – Pinene on reaction with dilute alkaline $KMnO_4$ produces a diol, which on further oxidation with chromium trioxide gives product A, which undergoes a positive haloform test. The compound A is

(a) 

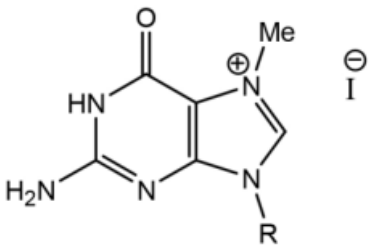
(b) 

(c) 

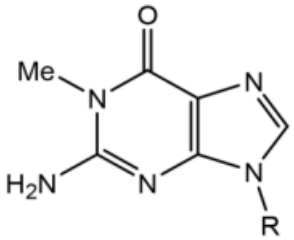
(d) 

Q.132 The major product formed in the reaction of guanosine with one equivalent of methyl iodide is

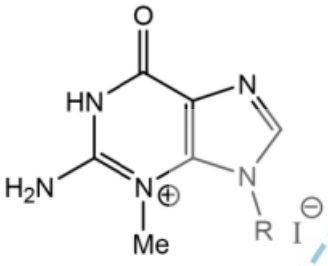
(a)



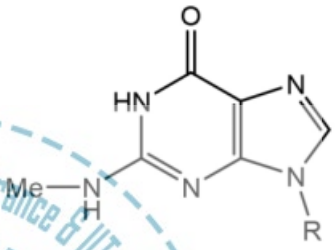
(b)



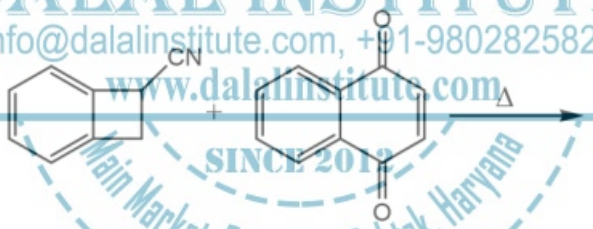
(c)



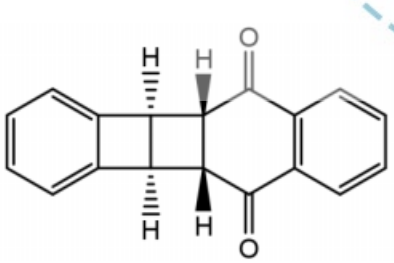
(d)



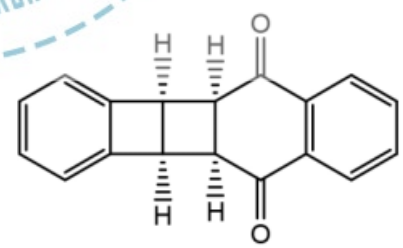
Q.133 The major product formed in the following reaction is



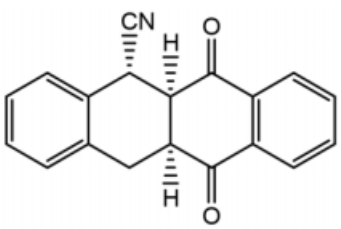
(a)



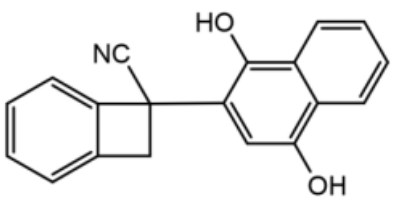
(b)



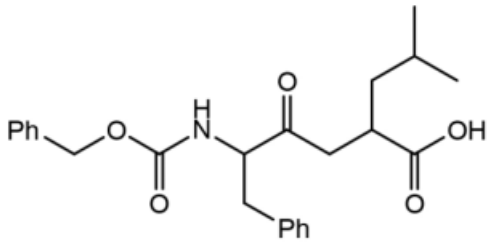
(c)



(d)



Q.134 Reaction of the dipeptide, given below, with hydrogen in the presence of 10% palladium over carbon, produces a mixture of



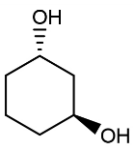
(a) Gly-Leu + toluene + carbon dioxide

(b) Phe-Leu + toluene + carbon dioxide

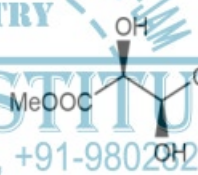
(c) Phe-Leu + benzyl alcohol + carbon dioxide

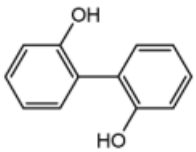
(d) Gly-Leu + benzyl alcohol + carbon dioxide

Q.135 Among the following, the most suitable reagent for carrying out resolution of racemic 3-methylcyclohexanone is

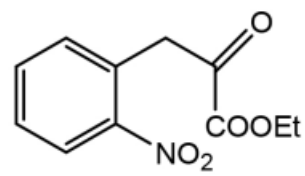
(a) 

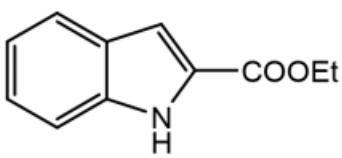
(b) 

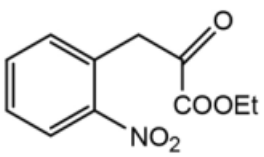
(c) 

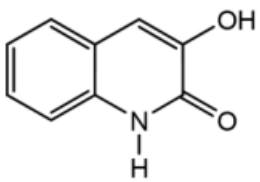
(d) 

Q.136 In the following reaction sequence, structures of the major product X and Y are

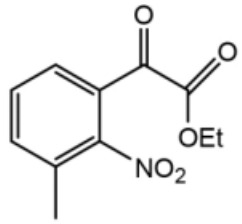
(a) X is 

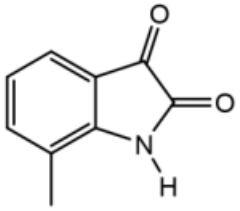
Y is 

(b) X is 

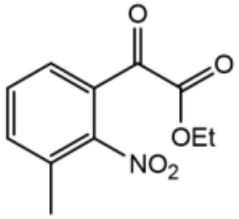
Y is 

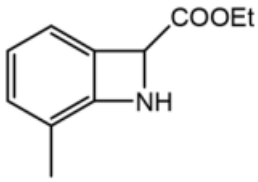
(c)

X is 

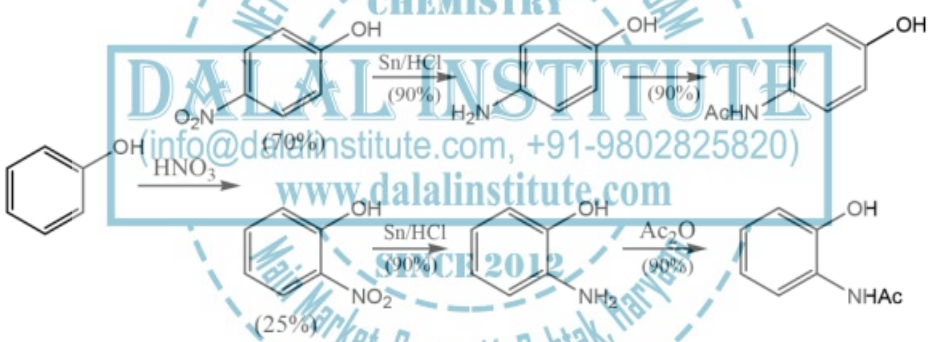
Y is 

(d)

X is 

Y is 

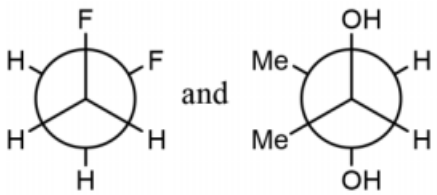
Q.137 Consider the following reaction sequence

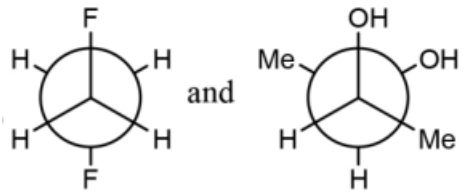


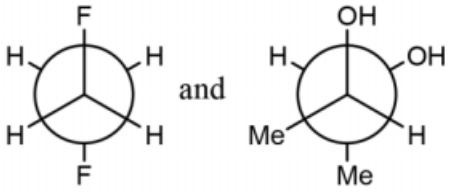
The overall yield for the formation of p-hydroxyacetanilide and o-hydroxyacetanilide from phenol, respectively, are approximately

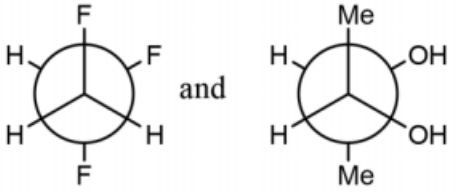
(a) 57 and 20% (b) 57 and 68% (c) 83 and 68% (d) 83 and 20%

Q.138 The most stable conformations of 1, 2-difluoroethane and dl-2, 3-butanediol are

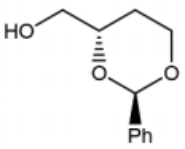
(a) 

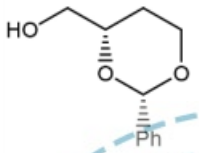
(b) 

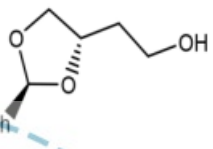
(c) 

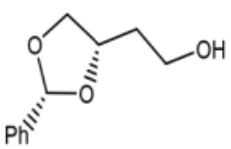
(d) 

Q.139 Reaction of (S)-1, 2, 4-butanetriol with benzaldehyde in the presence of catalytic amount of p-TSA furnished the major product A. The structure of A is

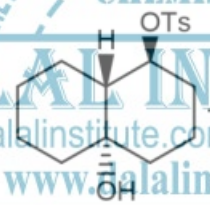
(a) 

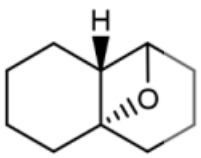
(b) 

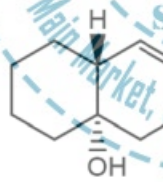
(c) 

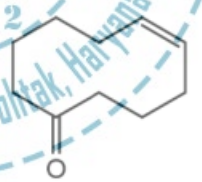
(d) 

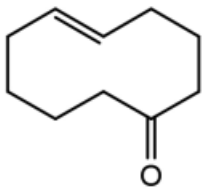
Q.140 The major product formed in the following reaction is



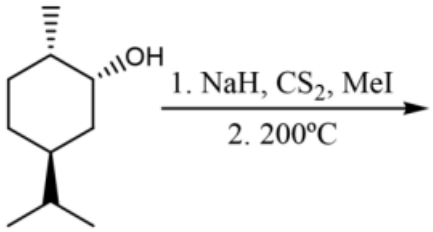
(a) 

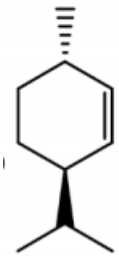
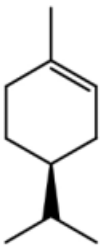
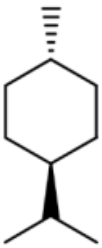
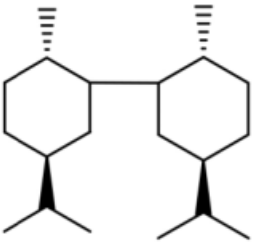
(b) 

(c) 

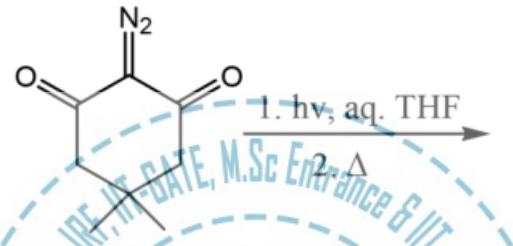
(d) 

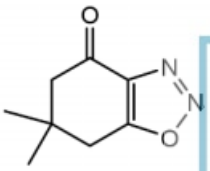
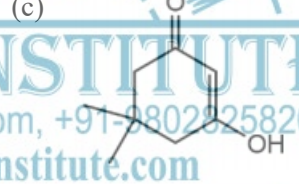
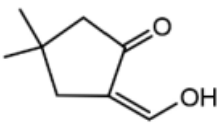
Q.141 The major product formed in the following reaction is



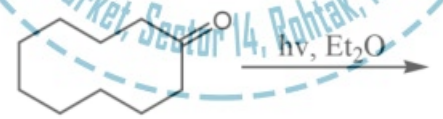
(a)  (b)  (c)  (d) 

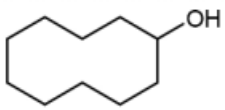
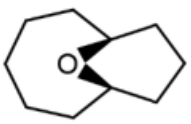
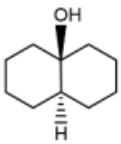
Q.142 The major product formed in the following reaction is



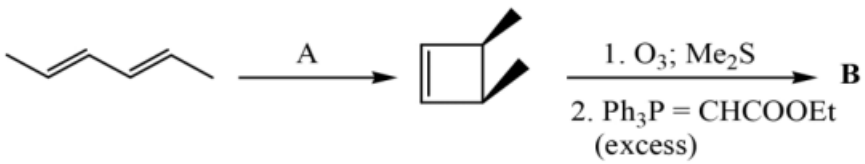
(a)  (b)  (c)  (d) 

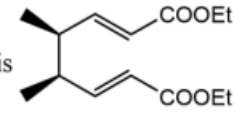
Q.143 The major product formed in the following reaction is

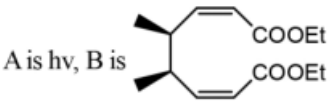


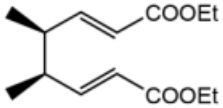
(a)  (b)  (c)  (d) 

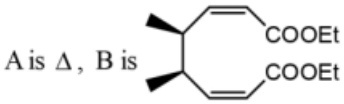
Q.144 Predict the condition A and the structure of the major product B in the following sequence.



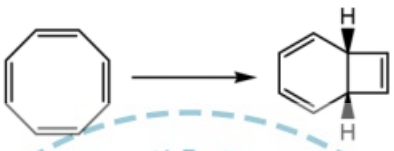
(a) A is hv, B is 

(b) A is hv, B is 

(c) A is Δ, B is 

(d) A is Δ, B is 

Q.145 The most appropriate mode of cyclisation in the following transformation is

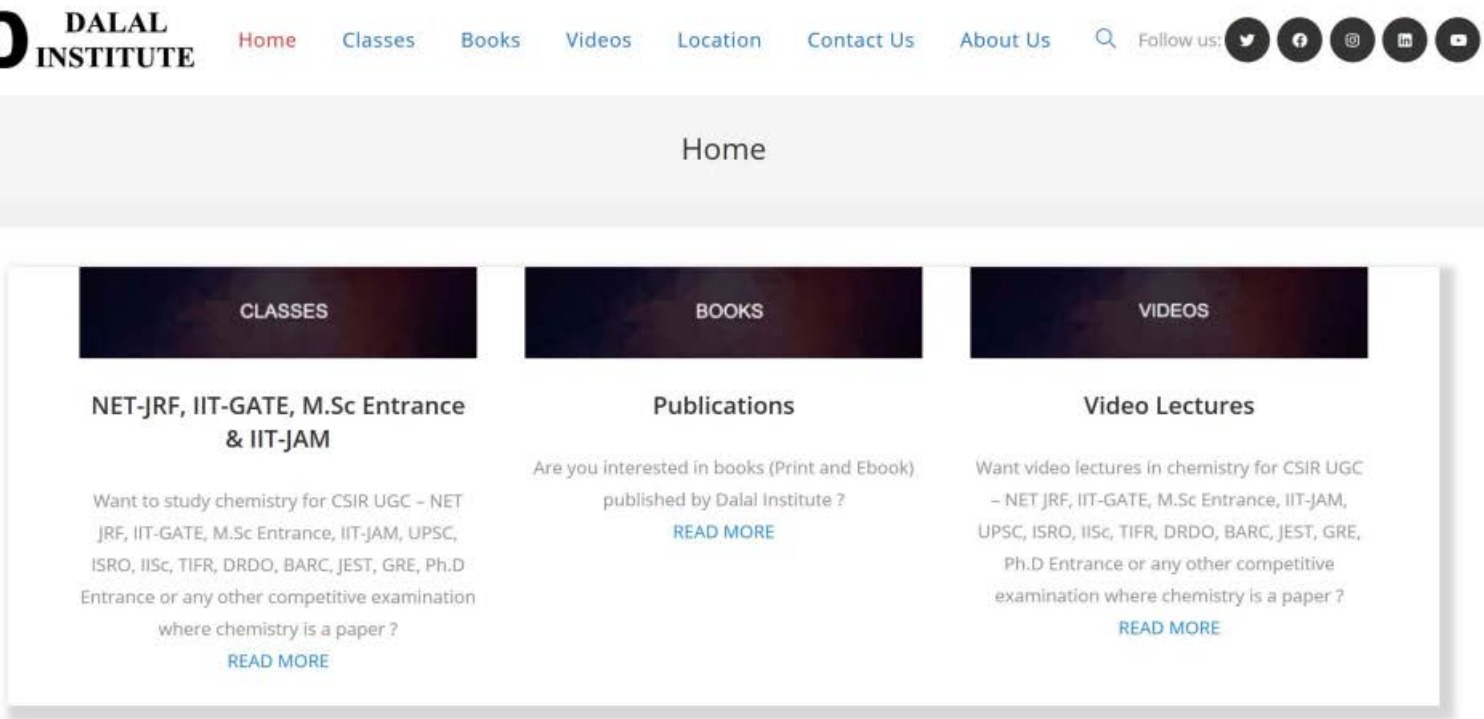


(a) Con-rotatory in photochemical; and dis-rotatory in thermal conditions.

(b) Con-rotatory in thermal; and dis-rotatory in photochemical conditions.

(c) Con-rotatory in thermal; and con-rotatory in photochemical conditions.

(d) Dis-rotatory in photochemical; and dis-rotatory in thermal conditions.



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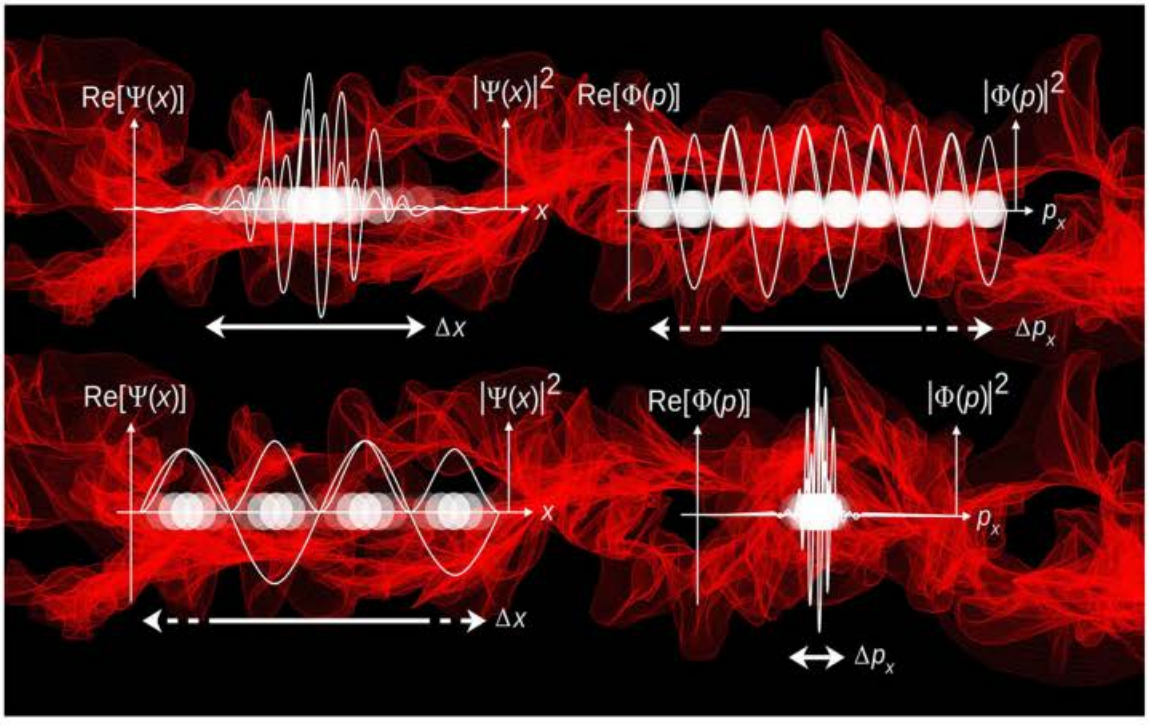

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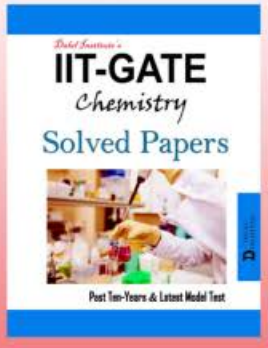

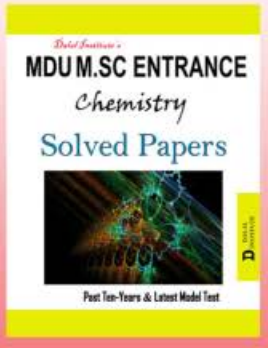

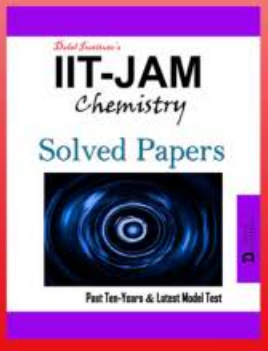

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